METHOD AND COMPUTER SYSTEM FOR EVALUATING THE COMPLEXITY OF A USER INTERFACE

Field of the Invention

The present invention generally relates to electronic
data processing, and more particularly, relates to
methods, computer program products and systems for
device independent document authoring.

Background of the Invention

Some software development platforms, such as the
Eclipse Platform, are designed for building integrated
development environments (IDEs) that can be used to
create applications as diverse as web sites, embedded
JavaTM programs, C++ programs, and Enterprise
JavaBeansTM.

Current IDEs support the development of user
interfaces for applications that are primarily foreseen
to interact with a homogenous delivery context (e.g., a
screen of low resolution, such as 800x600 pixels.)

However, more and more heterogeneous devices
access application servers running applications that
have been developed by using an IDE. Developers have to
adapt application user interfaces for different types
of delivery context. This task becomes increasingly
difficult with the prior art IDEs not providing
sufficient support for device independent development
of user interface documents.

Summary of the Invention

The present invention provides computer system, method
and computer program product according to the
independent claims for improving the support for device
independent authoring of user interface documents by

generating device class specific information about the complexity of the user interface by device class. A complexity indicator provides this information to the author supporting the author to identify complexity

5 problems in a user interface document related to device class specific restrictions during the development of the document. Thus, the author gains better control of a computer system that includes the complexity indicator and is used for the development of user

10 interfaces for various device classes, because the complexity indicator enables the author to quickly identify and solve problems of the user interface document related to device specific restrictions.

High complexity of a user interface typically has

15 a negative impact on the usability of the user interface. Identifying such problems at early stages of the development usually minimizes efforts for adjusting the document to better comply with the various device class specific restrictions. A result of the device

20 specific document analysis with the complexity indicator can also be that a user interface document cannot be used at all by devices belonging to a specific device class. In this case the author may not release the user interface document for the specific

25 device class.

The aspects of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the appended claims. Also, the described combination of the features of the

30 invention is not to be understood as a limitation, and all the features can be combined in other constellations without departing from the spirit of the invention. It is to be understood that both the foregoing general description and the following

35 detailed description are exemplary and explanatory only and are not restrictive of the invention as described.

Brief Description of the Drawings

FIG. 1 illustrates a complexity indicator according to
5        the invention as being part of an IDE;
FIG. 2 shows an alternative implementation of the
         complexity indicator with an abstraction layer;
         and
FIG. 3 shows an implementation of a complexity display
10       when integrated into the IDE main window.

Detailed Description of the Invention

FIG. 1 is a simplified block diagram of an integrated
development environment 999 (IDE) that can be used for
15   the development of user interface documents. The IDE
can be implemented as a computer program running on a
computer system that includes one or more computing
devices. The IDE 999 includes an editor 104 for editing
405 documents, such as a user interface document 300,
20   and an adaptation engine 105 for generating 420 device
class dependent representations 301, 302 of the
document 300. The IDE further includes a complexity
indicator 121 for calculating complexity values with
respect to the device specific representations 301,
25   302. The complexity indicator can be implemented as a
computer program product having instructions that when
loaded into a memory of the computer system can be
executed by at least one processor of the computer
system to perform an evaluation of the complexity of
30   the user interface.
        In the following description, by way of example,
the user interface document 300 includes a document
description in a Renderer Independent Markup Language

(RIML). However, the present invention can be applied
to any other document type, such as documents written
in Hypertext Markup Language (HTML), Extensible Markup
Language (XML), Java, etc. RIML is an XML based markup
5    language. The user interface document can be stored in
form of a file or any other suitable data structure.

The complexity indicator 121 provides special
support for the development of documents that are used
in mobile applications and, therefore, need to be
10   compatible with a variety of device classes. A device
class includes a plurality of restrictions that are
typical for devices (e.g., mobile devices) belonging to
the device class.

Adaptation engines, such as the consensus
15   adaptation engine, are known in the art. The adaptation
engine 105 is used to generate 420 the device class
specific representations 301, 302 of the document 300.
In general, the document 300 includes a layout
component hierarchy 320. This hierarchy 320 can be
20   adapted to various device classes DC1, DC2 in different
ways. This may result in the different representations
301, 302 of the document 300 for various device classes
DC1, DC2. For example, a specific layout component 3
may be suitable for a first device class DC1 but not a
25   second one DC2. This specific layout component 3 can be
suppressed by the adaptation engine 103 for the second
device class DC2 and, therefore, does not become part
of the document's representation 302 for the second
device class DC2. An appropriate preview tool may allow
30   the author to choose a specific emulator for a preview.
The output of the adaptation engine 103 is generated
for the chosen emulator. The author can browse through
generated sub-pages in the preview of the document.

The complexity indicator 121 has a complexity
35   evaluation library 121-1 for evaluating the complexity

of layout components 1 to 9 used in the document 300 or
its device specific representations 301, 302 and
further has a complexity display 121-2 for visualizing
440 the result of the complexity evaluation. High

5    complexity of layout components usually has a negative
impact on the usability of the user interface that
includes the layout components.

    The adaptation engine 105 receives 410 the
document 300 as input and generates 420 device specific

10   representations of the document considering specific
constraints of a device class (e.g., limited display
area, memory constraints). In the example, a first
representation 301 is generated for device class DC1
and a second representation 302 is generated for device

15   class DC2. Each representation can have a layout
component hierarchy 321, 322 that is different from the
one 320 of the original document 300. In the example,
the adaptation engine removed layout component 4 when
generating the first representation 301 and layout

20   component 3, when generating the second representation
302.

    The complexity indicator 121 receives 430
information about layout components 1 to 9 and how
these layout components are built into the layout

25   component hierarchies 321, 322 of the document
representations 301, 302. A layout component can
include multiple basic layout elements (e.g., input
fields) and group these layout elements in such a way
that a specific function  of the document (e.g.,

30   performing a search) is bundled in the layout
component. Sometimes layout components are also
referred to as controls.

    The complexity indicator 121 determines the layout
components and the layout component hierarchy 321, 322

35   of the respective representation 301, 302.

Further, the complexity indicator 121 calculates a
complexity value for each layout component in its
respective representation 301, 302. This can be
achieved·by using a complexity evaluation library 121-1

5    of the complexity indicator 121. It is sufficient that
the complexity indicator can access the library 121-1,
which may also be stored elsewhere within the IDE 999.
The library 121-1 includes a set of complexity
evaluation functions EF5-DC1, EF5-DC2, EF6-DC1, EF6-

10   DC2, etc. Preferably, such an evaluation function
exists for each layout component with respect to the
various device classes DC1, DC2. This can also be
achieved by associating the evaluation functions with
specific layout component types, where each layout

15   component is an instance of the respective layout
component type. The association of the evaluation
functions with the respective layout components is
illustrated by a solid line between a layout component
and its respective evaluation functions.

20       The complexity indicator 121 applies the
evaluation functions for the various device classes to
the associated layout components of the respective
representations 301, 302. Each applied evaluation
function returns a complexity value for the respective

25   layout component. For example, return values may range
from 1 to 10, where 1 indicates a low complexity of the
component and 10 indicates a high complexity of the
component. Any other appropriate measure can be used
instead. Evaluation criteria used by the evaluation

30   functions can, for example, refer to the number of
items that can be displayed simultaneously in the
display area of a specific device class or to the
number of broken links of the layout component,
dependent of the component layout type.·

Coding section 1 shows an example of an evaluation function for a select layout element in a PDA device class. For example, a Palm Pilot belongs to the PDA device class. The basic assumption is that a reasonable

5     number of items displayed on the Palm Pilot should not exceed 12.


Coding section 1:


```
10    int n = number of options
      bool sortedList = ?
      int items (area size ) = 12
      int UnsortedMaximalLevelTragetKnown = 36
      int MaxScreens = 6.5
15    IF (sortedList = TRUE)
            IF n <= items (area size ) return 1
            IF ((x <= MaxScreens) && (n <= x * items (area size) ) )
      return x
            ELSE return 10

20
```

Coding section 2 shows an example of an evaluation function for a select layout element in a cell phone device class. For example, a Nokia 7650 belongs to the cell phone device class. The basic assumption is that a

25    reasonable number of items displayed on the Nokia 7650 should not exceed 7.


Coding section 2:

```
      int n = number of options
30    bool sortedList = ?
      int items (area size ) = 7
      int UnsortedMaximalLevelTragetKnown = 20
      int MaxScreens = 5.5
      IF (sortedList = TRUE)
35          IF n <= items (area size ) return 1
```

```
        IF ((x <= MaxScreens) && (n <= x * items (area size) ) )
return x
        ELSE return 10
```

5       Then, the complexity indicator aggregates the
        returned complexity values for the various
        representations 301, 302 according to the respective
        layout component hierarchies 321, 322. Aggregate
        complexity values can be determined for the various
10      levels in the layout component hierarchies 321, 322.
        For example, layout component 2 may represent a
        menu that includes two sub-menus (layout components 5
        and 6). When applying the evaluation functions EF5-DC1
        and EF6-DC1 to the sub-menus 5, 6 for the first device
15      class DC1 (first representation 301), the aggregation
        algorithm may propagate the maximum complexity value of
        both sub-menus to the menu 2, assuming that the
        complexity value of the menu 2 cannot be less than the
        highest complexity value of is sub-menus. The same
20      applies to the second device class DC2 when applying
        the evaluation functions EF5-DC2 and EF6-DC2. However,
        even in case that both sub-menus 5, 6 have a low
        complexity value, the overall complexity of the menu 2
        can still be higher. Therefore, in addition to
25      propagating complexity values of child nodes in the
        layout component hierarchy to the parent node, an
        evaluation function can be applied directly to the
        parent node. For example, the sub-menus can have
        complexity values of "3" and "5". However, the usage of
30      both sub-menus in the menu 2 can lead to a complexity
        value "7" for the menu 2 (parent node) itself. Thus,
        the propagated complexity value of the sub-menus
        max("3";"5")="5" would be overruled by the complexity
        indicator with the higher complexity value "7" that is
35      directly calculated for the parent node (menu 2).

The complexity indicator can then visualize 440
the various complexity values for the author in a
complexity display 121-2. For example, the aggregate
complexity values "4" and "8" for the respective
5    component hierarchies 321, 322 can be displayed for
each device class DC1, DC2.


FIG. 2 illustrates an alternative implementation of the
complexity indicator 121, where the complexity
10   indicator processes complexity evaluation hierarchies
instead of layout component hierarchies. For this
purpose, the complexity indicator 121 can include a
transformer 121-3 that can transform the layout
component hierarchy 321, 322 of each representation
15   301, 302 into a corresponding markup language
independent complexity evaluation hierarchy 521, 522.
The complexity evaluation hierarchy 521, 522 includes
the same information as the respective layout component
hierarchy 321, 322 but is described in a generic
20   language to which the evaluation functions can be
applied. Using a language independent complexity
evaluation hierarchy enables the complexity indicator
to use a single set of evaluation functions being
associated with components c1 to c9 of the complexity
25   evaluation hierarchy 521, 522 in the complexity library
121-1. This association becomes independent from the
markup language being used for the original document
300 or its device specific representations 301, 302.
The complexity hierarchy layer is an abstraction layer
30   between the representations 301, 302 and the complexity
evaluation functions of the library 121-1 that helps to
avoid that an evaluation function for a layout
component needs to be redundantly provided for various
markup languages, such as RIML, XHTML, HTML, etc.

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FIG. 3 shows an alternative implementation of the
complexity display 121-2 when integrated into the IDE
graphical user interface (GUI).

The complexity values for each device class DC1,
5   DC2 are visualized as graphical bars 21, 22. In the
example, complexity values increase from the left value
1 to the right value 10. Threshold values T1, T2 are
used to change the appearance of the bars 21, 22
dependent on the visualized threshold value. For
10  example, complexity values below T1 have a first grid
structure or a first colour. Complexity values between
T1 and T2 have a second grid structure or a second
colour and complexity values above T2 have a third grid
structure or a third colour. Other presentations, such
15  as traffic lights changing the colour when exceeding a
threshold value, are also possible.

The complexity display 121-2 further can have a
drill down section 121-2', where complexity values can
be shown on different hierarchy levels down to the
20  complexity of an isolated layout component for a
selected device class. In the example, the drill down
is made for the second device class DC2. Apparently,
the high complexity value originates from the layout
component 2, whereas the complexity value of layout
25  components 4 and 7 is relatively low. A further drill
down can be made for each of the layout components to
determine the origin of high complexity values.

A tree-based outline editor 109 can be interfaced
to the complexity indicator 121 so that, when it is
30  displayed simultaneously on the IDE GUI, a layout
component that is selected in the complexity display
121-2 is highlighted in the component hierarchy 322
shown in the tree-based outline editor 109.

In general, the tree-based outline editor 109 can
35  generate an outline view of the edited document 300 or

its device specific representation 301, 302, such as an
XML tree view of a RIML document. For example, the
outline view can be a graphical display of the
corresponding layout component hierarchy.

5          In this example the tree-based outline editor 109
displays the layout component hierarchy 322 of the
respective representation 302 that corresponds to the
device class DC2 that is currently drilled down in the
complexity indicator.

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Embodiments of the invention can be implemented in
digital electronic circuitry, or in computer hardware,
firmware, software, or in combinations of them.  The
invention can be implemented as a computer program
15    product, i.e., a computer program tangibly embodied in
an information carrier, e.g., in a machine-readable
storage device or in a propagated signal, for execution
by, or to control the operation of, data processing
apparatus, e.g., a programmable processor, a computer,
20    or multiple computers. An computer program for device
dependent authoring of user interface documents
including a complexity indicator as described above can
be written in any form of programming language,
including compiled or interpreted languages, and it can
25    be deployed in any form, including as a stand-alone
program or as a module, component, subroutine, or other
unit suitable for use in a computing environment. A
computer program can be deployed to be executed on one
computer or on multiple computers at one site or
30    distributed across multiple sites and interconnected by
a communication network.

          Method steps of the invention can be performed by
one or more programmable processors executing a
computer program to perform functions of the invention
35    by operating on input data and generating output.
Method steps can also be performed by, and apparatus of
the invention can be implemented as, special purpose

logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit).

5       Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory

10   or both. The essential elements of a computer are at least one processor for executing instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer

15   data to, or both, one or more mass storage devices for storing data, e.g., magnetic, magneto-optical disks, or optical disks. Information carriers suitable for embodying computer program instructions and data include all forms of non-volatile memory, including by

20   way of example semiconductor memory devices, e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD-ROM and DVD-ROM disks. The processor and the memory can be supplemented by, or

25   incorporated in special purpose logic circuitry.

      To provide for interaction with a user, the invention can be implemented on a computer having a display device, e.g., a cathode ray tube (CRT) or liquid crystal display (LCD) monitor, for displaying

30   information to the user and a keyboard and a pointing device, e.g., a mouse or a trackball, by which the user can provide input to the computer. Other kinds of devices can be used to provide for interaction with a user as well; for example, feedback provided to the

35   user can be any form of sensory feedback, e.g., visual feedback, auditory feedback, or tactile feedback; and

input from the user can be received in any form, including acoustic, speech, or tactile input.

The invention can be implemented in a computing system that includes a back-end component, e.g., as a
5 data server, or that includes a middleware component, e.g., an application server, or that includes a front-end component, e.g., a client computer having a graphical user interface or a Web browser through which a user can interact with an implementation of the
10 invention, or any combination of such back-end, middleware, or front-end components. The components of the system can be interconnected by any form or medium of digital data communication, e.g., a communication network. Examples of communication networks include a
15 local area network (LAN) and a wide area network (WAN), e.g., the Internet.

The computing system can include clients and servers. A client and server are generally remote from each other and typically interact through a
20 communication network. The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other.